JS 44 (Rev. 11/04)

CIVIL COVER SHEET

APPENDIX H

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. (SEE INSTRUCTIONS ON THE REVERSE OF THE FORM.)

I. (a) PLAINTIFFS
HERAEUS ELECTRO-NITE CO.
One Summit Square #100
Langhorne, Pennsylvania 19047

(b) County of Residence of First Listed Plaintiff Bucks
(EXCEPT IN U.S. PLAINTIFF CASES)

DEFENDANTS
MIDWEST INSTRUMENT COMPANY, INC.
541 Industrial Drive
Hartland, Wisconsin 53029

County of Residence of First Listed Defendant Waukesha
(IN U.S. PLAINTIFF CASES ONLY)

NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE LAND INVOLVED.

(c) Attorney's (Firm Name, Address, and Telephone Number) 215-965-1200
JASON A. SNYDERMAN AND R. BRENDAN FEE, ESQS.
AKIN GUMP, ET AL., 2005 Market Street, Suite 2200, Phila., PA 19103-7013

Attorneys (If Known)

II. BASIS OF JURISDICTION (Place an "X" in One Box Only)

- ☐ 1 U.S. Government Plaintiff
- ☒ 3 Federal Question (U.S. Government Not a Party)
- ☐ 2 U.S. Government Defendant
- ☐ 4 Diversity (Indicate Citizenship of Parties in Item III)

III. CITIZENSHIP OF PRINCIPAL PARTIES (Place an "X" in One Box for Plaintiff and One Box for Defendant)
(For Diversity Cases Only)

	PTF	DEF		PTF	DEF
Citizen of This State	☐ 1	☐ 1	Incorporated *or* Principal Place of Business In This State	☐ 4	☐ 4
Citizen of Another State	☐ 2	☐ 2	Incorporated *and* Principal Place of Business In Another State	☐ 5	☐ 5
Citizen or Subject of a Foreign Country	☐ 3	☐ 3	Foreign Nation	☐ 6	☐ 6

IV. NATURE OF SUIT (Place an "X" in One Box Only)

CONTRACT
- ☐ 110 Insurance
- ☐ 120 Marine
- ☐ 130 Miller Act
- ☐ 140 Negotiable Instrument
- ☐ 150 Recovery of Overpayment & Enforcement of Judgment
- ☐ 151 Medicare Act
- ☐ 152 Recovery of Defaulted Student Loans (Excl. Veterans)
- ☐ 153 Recovery of Overpayment of Veteran's Benefits
- ☐ 160 Stockholders' Suits
- ☐ 190 Other Contract
- ☐ 195 Contract Product Liability
- ☐ 196 Franchise

REAL PROPERTY
- ☐ 210 Land Condemnation
- ☐ 220 Foreclosure
- ☐ 230 Rent Lease & Ejectment
- ☐ 240 Torts to Land
- ☐ 245 Tort Product Liability
- ☐ 290 All Other Real Property

TORTS

PERSONAL INJURY
- ☐ 310 Airplane
- ☐ 315 Airplane Product Liability
- ☐ 320 Assault, Libel & Slander
- ☐ 330 Federal Employers' Liability
- ☐ 340 Marine
- ☐ 345 Marine Product Liability
- ☐ 350 Motor Vehicle
- ☐ 355 Motor Vehicle Product Liability
- ☐ 360 Other Personal Injury

PERSONAL INJURY
- ☐ 362 Personal Injury - Med. Malpractice
- ☐ 365 Personal Injury - Product Liability
- ☐ 368 Asbestos Personal Injury Product Liability

PERSONAL PROPERTY
- ☐ 370 Other Fraud
- ☐ 371 Truth in Lending
- ☐ 380 Other Personal Property Damage
- ☐ 385 Property Damage Product Liability

CIVIL RIGHTS
- ☐ 441 Voting
- ☐ 442 Employment
- ☐ 443 Housing/ Accommodations
- ☐ 444 Welfare
- ☐ 445 Amer. w/Disabilities - Employment
- ☐ 446 Amer. w/Disabilities - Other
- ☐ 440 Other Civil Rights

PRISONER PETITIONS
- ☐ 510 Motions to Vacate Sentence

Habeas Corpus:
- ☐ 530 General
- ☐ 535 Death Penalty
- ☐ 540 Mandamus & Other
- ☐ 550 Civil Rights
- ☐ 555 Prison Condition

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- ☐ 620 Other Food & Drug
- ☐ 625 Drug Related Seizure of Property 21 USC 881
- ☐ 630 Liquor Laws
- ☐ 640 R.R. & Truck
- ☐ 650 Airline Regs.
- ☐ 660 Occupational Safety/Health
- ☐ 690 Other

LABOR
- ☐ 710 Fair Labor Standards Act
- ☐ 720 Labor/Mgmt. Relations
- ☐ 730 Labor/Mgmt.Reporting & Disclosure Act
- ☐ 740 Railway Labor Act
- ☐ 790 Other Labor Litigation
- ☐ 791 Empl. Ret. Inc. Security Act

BANKRUPTCY
- ☐ 422 Appeal 28 USC 158
- ☐ 423 Withdrawal 28 USC 157

PROPERTY RIGHTS
- ☐ 820 Copyrights
- ☒ 830 Patent
- ☐ 840 Trademark

SOCIAL SECURITY
- ☐ 861 HIA (1395ff)
- ☐ 862 Black Lung (923)
- ☐ 863 DIWC/DIWW (405(g))
- ☐ 864 SSID Title XVI
- ☐ 865 RSI (405(g))

FEDERAL TAX SUITS
- ☐ 870 Taxes (U.S. Plaintiff or Defendant)
- ☐ 871 IRS—Third Party 26 USC 7609

OTHER STATUTES
- ☐ 400 State Reapportionment
- ☐ 410 Antitrust
- ☐ 430 Banks and Banking
- ☐ 450 Commerce
- ☐ 460 Deportation
- ☐ 470 Racketeer Influenced and Corrupt Organizations
- ☐ 480 Consumer Credit
- ☐ 490 Cable/Sat TV
- ☐ 810 Selective Service
- ☐ 850 Securities/Commodities/ Exchange
- ☐ 875 Customer Challenge 12 USC 3410
- ☐ 890 Other Statutory Actions
- ☐ 891 Agricultural Acts
- ☐ 892 Economic Stabilization Act
- ☐ 893 Environmental Matters
- ☐ 894 Energy Allocation Act
- ☐ 895 Freedom of Information Act
- ☐ 900Appeal of Fee Determination Under Equal Access to Justice
- ☐ 950 Constitutionality of State Statutes

V. ORIGIN (Place an "X" in One Box Only)

☒ 1 Original Proceeding ☐ 2 Removed from State Court ☐ 3 Remanded from Appellate Court ☐ 4 Reinstated or Reopened ☐ 5 Transferred from another district (specify) ☐ 6 Multidistrict Litigation ☐ 7 Appeal to District Judge from Magistrate Judgment

VI. CAUSE OF ACTION
Cite the U.S. Civil Statute under which you are filing (**Do not cite jurisdictional statutes unless diversity**):
35 U.S.C. Section 1
Brief description of cause:
Patent Infringment

VII. REQUESTED IN COMPLAINT:
☐ CHECK IF THIS IS A CLASS ACTION UNDER F.R.C.P. 23
DEMAND $ Unknown
CHECK YES only if demanded in complaint:
JURY DEMAND: ☒ Yes ☐ No

VIII. RELATED CASE(S) IF ANY (See instructions): JUDGE _____ DOCKET NUMBER _____

DATE 1/26/06
SIGNATURE OF ATTORNEY OF RECORD

FOR OFFICE USE ONLY

RECEIPT # _____ AMOUNT _____ APPLYING IFP _____ JUDGE _____ MAG. JUDGE _____

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF PENNSYLVANIA

HERAEUS ELECTRO-NITE CO. *Plaintiff,* v. MIDWEST INSTRUMENT COMPANY, INC. *Defendants*	Civil Action No. JURY TRIAL DEMANDED

COMPLAINT

Plaintiff Heraeus Electro-Nite Co. ("Electro-Nite") by and through its undersigned counsel, for its Complaint against Defendant Midwest Instrument Company, Inc. ("Minco"), states as follows:

NATURE OF THE ACTION

1. This is a civil action under the patent laws of the United States, 35 U.S.C. § 1 *et seq.*, for infringement of U.S. Patent No. 4,964,736 ("the '736 patent").

PARTIES

2. Plaintiff Electro-Nite is a Delaware corporation with its principal place of business at One Summit Square #100, Langhorne, Pennsylvania 19047. Electro-Nite is the owner of all right, title, and interest in and to the '736 patent.

3. Upon information and belief, Defendant Minco is a Wisconsin corporation with its principal place of business at 541 Industrial Drive, Hartland, Wisconsin 53029. Upon information and belief, Defendant Minco is subject to personal jurisdiction in this district, as it infringes the '736 patent by selling, and/or offering for sale, and/or contributing to and/or inducing others to sell and/or

offer for sale products, more fully described herein, in this district, without Electro-Nite's authorization, license, or consent.

JURISDICTION AND VENUE

4. This Court has jurisdiction over this action pursuant to 28 U.S.C. §§ 1331, 1332, and 1338(a).

5. Venue in this Court is proper under 28 U.S.C. §§ 1391(b) and (c) and § 1400(b), in that, upon information and belief, a substantial portion of the infringing activities occurred in this district.

THE PATENT IN SUIT

6. On October 23, 1990, the '736 patent entitled "Immersion Measuring Probe for Use in Molten Metals," and naming Omer Cure and Theo P.C. Bollen as joint inventors, was duly and legally issued. A true and accurate copy of the '736 patent is attached to this Complaint as Exhibit "A".

7. Plaintiff Electro-Nite became owner of all right, title and interest in and to the '736 patent by virtue of an assignment recorded as of February 19, 2004 at Reel 014980, beginning at Frame 0091.

8. The '736 patent is valid and enforceable, and all maintenance payments have been made.

CLAIMS FOR PATENT INFRINGEMENT

9. Plaintiff repeats and incorporates by reference, as if fully set forth herein, the allegations in paragraphs 1 through 8 above.

10. Upon information and belief, Defendant Minco has infringed and continues to infringe one or more claims of the '736 patent, in violation of 35 U.S.C. § 271, by manufacturing, using, selling and/or offering for sale, and/or contributing to and/or inducing others to make, use, sell, and/or

offer for sale in the United States and/or importing into the United States products which incorporate the claimed features of the '736 patent, including, but not limited to, molten metal immersion probes. Such acts of infringement are occurring, have occurred in the past, and will continue to occur without the authority or license of Electro-Nite unless this Court enjoins Defendant Minco's infringing activities.

11. Upon information and belief, Defendant Minco has willfully and deliberately conducted the infringing activities described in paragraph 10 above since at least as early as 1999, warranting the assessment of increased damages pursuant to 35 U.S.C. § 284, and the award of Electro-Nite's attorneys fees, as this is an exceptional case pursuant to 35 U.S.C. § 285.

12. Electro-Nite markets products that compete or competed with Defendant Minco's infringing products and sales and profits for these products have been diminished by the sale of Defendant's infringing products. As a result of the sale and distribution of Defendant's infringing products, Electro-Nite has lost profits.

13. Electro-Nite has been, is being, and will continue to be damaged by Defendant Minco's infringing activities. Electro-Nite's harm resulting from Defendant's infringement is irreparable and cannot be remedied in its entirety by the recovery of money damages, and Electro-Nite has no adequate remedy at law.

PRAYER FOR RELIEF

WHEREFORE, Electro-Nite prays for judgment and relief against Defendant Minco as follows:

(i) That this Court, pursuant to 35 U.S.C. § 283, issue an injunction permanently enjoining Minco, its principals, officers, directors, agents, servants, employees, and all those persons

in active concert or participation with Minco, from further infringement and/or contributing to and/or inducing the infringement of Electro-Nite's '736 patent.

(ii) That this Court, pursuant to 35 U.S.C. § 284, enter judgment against Minco for damages for infringement, including lost profits and royalties, from as early as 1999, including treble damages because of the willful and deliberate nature of such infringement;

(iii) That this Court, pursuant to 35 U.S.C. § 285, award Electro-Nite its attorneys' fees in connection with this action;

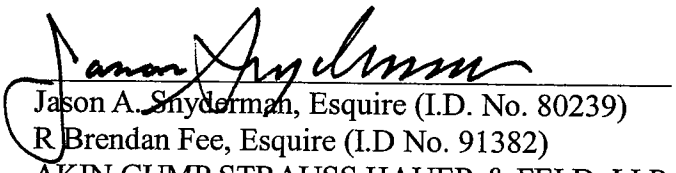
(iv) That this Court award Electro-Nite its costs and pre-judgment interest; and

(v) That this Court grant such other and further relief to Electro-Nite as this Court may deem just and proper.

DEMAND FOR JURY TRIAL

Electro-Nite demands a trial by jury as to all issues triable by jury in this action.

Respectfully submitted,



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Attorneys for Plaintiff,
Heraeus Electro-Nite Co.

EXHIBIT "A"

United States Patent [19]

Cure et al.

[11] **Patent Number: 4,964,736**

[45] **Date of Patent: Oct. 23, 1990**

[54] **IMMERSION MEASURING PROBE FOR USE IN MOLTEN METALS**

[75] Inventors: **Omer Cure**, Diepenbeek; **Theo P. C. Bollen**, Genk, both of Belgium

[73] Assignee: **Electro-Nite Co.**, Philadelphia, Pa.

[21] Appl. No.: **331,091**

[22] Filed: **Mar. 27, 1989**

Related U.S. Application Data

[63] Continuation of Ser. No. 780,707, Sep. 26, 1985, abandoned, which is a continuation of Ser. No. 513,532, Jul. 13, 1983, abandoned.

[30] **Foreign Application Priority Data**

Oct. 8, 1982 [BE] Belgium 59866

[51] **Int. Cl.**[5] **G01K 1/12**

[52] **U.S. Cl.** **374/140**; 374/139; 374/140; 136/234

[58] **Field of Search** 374/139, 140, 157, 142; 136/230, 232, 234; 204/422, 423, 210

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,106,493	10/1963	Japka	136/234
3,288,654	11/1966	Perrin et al.	374/140
3,306,783	2/1967	Silver	136/234
3,353,808	11/1967	Norburn	374/140
3,379,578	4/1968	Mctaggart et al.	136/234
3,610,045	10/1971	Shearman	374/139
3,616,407	10/1971	Engell et al.	204/423
3,643,509	2/1972	Surinx	374/140
3,657,094	4/1972	Hans et al.	204/422
3,784,459	1/1974	Jackson	204/423
3,785,947	1/1974	Baldwin et al.	136/234
3,791,209	2/1974	Norburn	374/140
4,342,633	8/1982	Cure	204/423
4,401,389	8/1983	Theuwis	374/140

FOREIGN PATENT DOCUMENTS

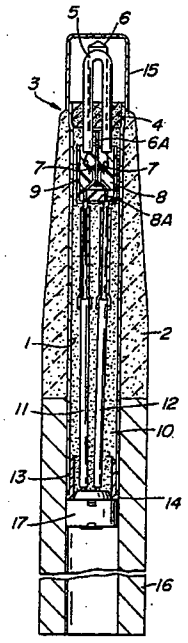
1928845	5/1970	Fed. Rep. of Germany .	
1953580	11/1970	Fed. Rep. of Germany	204/422
2207307	8/1973	Fed. Rep. of Germany	374/140
144620	4/1962	U.S.S.R. .	
842107	4/1978	U.S.S.R. .	
1094180	12/1967	United Kingdom .	

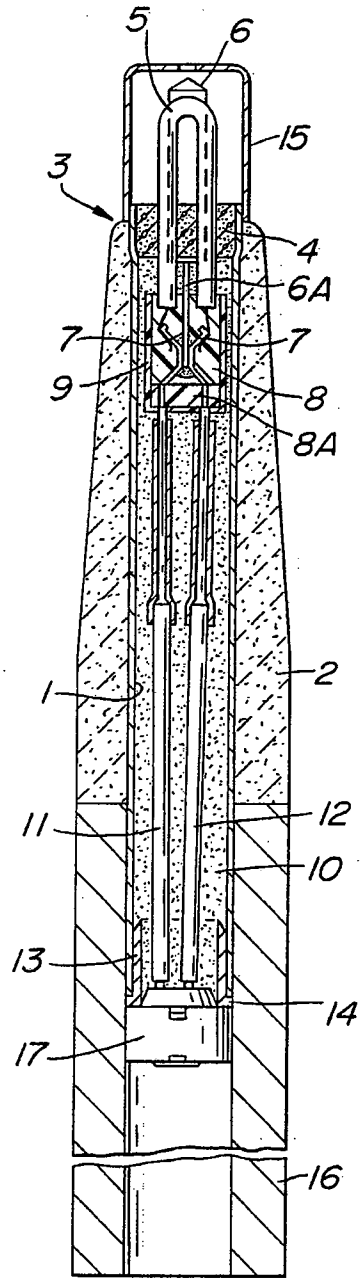
Primary Examiner—William A. Cuchlinski, Jr.
Assistant Examiner—Patrick R. Scanlon
Attorney, Agent, or Firm—Panitch Schwarze Jacobs & Nadel

[57] **ABSTRACT**

An immersion probe as a preassembled unit includes a measuring head having a measuring element protected for minimizing trapping of gases by a sheath. The sheath is tapered toward a free end. The probe is adapted to be immersed in molten metal for measuring temperature and/or oxygen content.

7 Claims, 1 Drawing Sheet

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IMMERSION MEASURING PROBE FOR USE IN MOLTEN METALS

This application is a continuation of application Ser. No. 780,707, filed Sept. 26, 1985 and now abandoned, which was a continuation of application Ser. No. 513,532, filed July 13, 1983 and now abandoned.

FIELD OF THE INVENTION

The present invention is directed to an immersion measuring probe for measuring a characteristic of molten metal such as temperature and/or oxygen content.

BACKGROUND

Immersion measuring probes of the general type involved herein are disclosed in a number of prior art patents. For example, see Belgian patent Nos. 828,572; 881,886; 884,405; and 889,276. The prior art patents are generally characterized by a measuring head supported at one end of a paperboard tube. The paperboard tube is provided for its insulating protection when the probe is immersed into molten metal.

An oxygen probe supported by a quartz sheath of uniform wall thickness is taught by British Patent No. 1,094,180. A protective sheath of quartz is objectionable since quartz is transparent to thermal radiation. An oxygen probe supported by a quartz tube partially protected by a tapered graphite sleeve is taught by German Patent No. 1,928,845. The use of graphite as a protective sleeve is objectionable since it combines with oxygen with the result that the graphite sleeve burns off.

It has been found that the prior art probes of the type involved herein are inaccurate due to several features relating to the manner in which said prior art probes are constructed. A large number of solutions involving changes of material as well as changes in construction were investigated. In order to make a satisfactory probe which will give uniform accurate results, it was ascertained that the probe must meet the following criteria:

(a) A considerable reduction of the mass in the vicinity of the measuring was needed to diminish the cooling effect on the metal and thus enable more accurate measurements to be made quicker and at lower temperatures;

(b) When the probe includes a thermocouple, the temperature difference between its cold joints during immersion and temperature meaurement should be reduced;

(c) When the probe includes an oxygen sensor, it should be a solid electro-chemical cell and means should be provided to minimize the influence of oxygen liberated from the oxygen sensor so as to prevent liberated oxygen and other gases from being trapped adjacent to the sensor and thereby giving erroneous readings.

The probe of the present invention is directed to a solution of said problems.

SUMMARY OF THE INVENTION

The present invention is directed to an immersion probe which comprises unit including a support tube which defines the outer periphery of the unit. One end of the tube is an immersion end. At least one measuring element is supported on a measuring head which closes said tube adjacent its immersion end. A connector closes the other end of said tube. Electrical conductors in said tube extend from said connector to said measuring element. Heat insulating material is provided in said tube for protecting said conductors.

A means is provided on the tube for protecting the tube and for minimizing the ability of gasses to be trapped adjacent said measuring element. The means includes a heat insulating refractory sheath telescoped over a major portion of said tube beginning at the immersion of said tube. The sheath tapers toward the immersion end of the tube with the minimum wall thickness of the sheath being at said immersion end. The tube has an electrical conductive portion projecting beyond the sheath for contact with a bath of molten metal and is electrically coupled to said connector. An elongated hollow support is telescopically coupled to the other end of the tube for supporting the tube and the sheath during immersion into a bath of molten metal.

For the purpose of illustrating the invention, there is shown in the drawing, a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

The drawing illustrates a longitudinal sectional view of the probe.

DETAILED DESCRIPTION

The measuring probe includes a preassembled unit with the outer periphery of such unit being defined by a cylindrical tube **1**. The tube **1** is preferably a metal tube made from a material such as low carbon steel. The immersion end **3** of the probe is sealed by a plug of refractory heat resistant material such as cement. Plug **4** constitutes a measuring head for supporting one or more measuring elements. As illustrated, the measuring head supports the thermocouple **5** partially disposed within the quartz tube coated with aluminum oxide and a solid electrolite electro-chemical oxygen sensing cell **6**, a portion of which extends into the tube beyond the plug **4** opposite the emerging end.

The cold joints **7** of the thermocouple **5** are embedded in a gas tight enclosure such as a body of silicone **8** surrounded by a small plastic casing **9**. The conductors at the cold joints **7** are V-shaped with the apexes adjacent one another but electrically insulated from one another by the silicone **8**. The bottom wall of the casing **9** may be separable and defined by a plastic disk **8A**. The tube **1** is filled with a heat insulating material free from crystal water such as resin coated molding sand **10** packed loosely so as to be gas permeable and through which conductors **11** and **12** pass. Conductors **11** and **12** extend from the cold joints **7** to a connector **17**. Connector **17** has an electrically conductive sleeve **13** in intimate contact with the electrically conductive tube **1**. An electrical conductor **6A** extends between the oxygen sensor **6** and one of the cold joints **7**. Tube **1** acts as a conductor for closing the circuit of the cell **6**.

A heat insulating refractory sheath **2** is telescoped over the major length of the tube **1** beginning at the immersion end **3**. The sheath **2** is supported by the tube **1** and is bonded thereto in any convenient manner. Sheath **2** is tapered along a major portion of its length toward the immersion end **3** for protecting the tube **1** and for minimizing the ability of gasses to be trapped adjacent the measuring elements **5** and **6**. Sheath **2** is preferably made from a refractory material such as resin coated molding sand. Sheath **2** could be made from other materials such as aluminum oxide or zirconium oxide but should not be made from quartz or graphite.

In order that the tube **1** may perform the additional function of completing the circuit for the oxygen sensor **6**, it projects beyond the immersion end of the sheath **2** so that it may contact the molten bath after the protective cap **15** is consumed by the bath as the probe is inserted through a layer of slag. To facilitate immersing the probe into molten metal, a support is provided in the form of a paperboard tube **16** which is force-fit over the tube **1**. Adjacent ends of the sheath **2** and support **16** are in contact with one another.

The preferred dimensions for the sheath **2** are by way of example: a length of 10 centimeters, an external diameter of 2.5 centimeters at the immersion end **3**, maximum external diameter of 3.7 to 4.8 centimeters; and an internal diameter of about 1.8 centimeters.

In addition to increased accuracy, the probe of the present invention has other advantages: small mass of materials in the vicinity of the measuring elements, excellent protection of the cold joints against mutual temperature differences, a favorable shape for causing the probe to penetrate the bath, etc. Other advantages include the ability to preassemble the probe on a production line basis. In this regard, the electrically conductive tube **1** performs the dual function of providing support for elements therewithin which may be preassembled as a unit and then joined to the sheath **2** and support **16** in an economical manner requiring little or no skill on the part of the workers.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specifications, as indicating the scope of the invention.

I claim:

1. An immersion measuring probe for measurements in a molten metal bath comprising:

an elongated hollow electrically conductive tube, said tube having an immersion end and a connector end;

a measuring head closing the internal portion of said immersion end of said tube, said measuring head having

a non-conductive support plug,

a thermocouple element supported by said plug and having one end projecting from said immersion end of said tube and an electrically conductive portion extending into said tube beyond said plug,

an electro-chemical cell extending through said plug having one end adjacent to said projecting end of the thermocouple element and an electronically conductive portion extending into said tube beyond said plug;

a gas impermeable enclosure receiving the electrically conductive portions of said thermocouple and said cell, said enclosure being closely adjacent to said measuring head within said tube;

electrical conductors extending from said enclosure to said connector end of said tube;

an electrical connector closing said connector end of said tube and providing electrical connections for said thermocouple, said cell and said tube;

said tube between said plug and said connector being filled with a heat insulating particulate material which is loosely packed such that it is gas permeable;

a sheathing surrounding a major portion of the length of said tube, said sheathing being made of a fireproof, refractory heat resistant material attached to the exterior of said tube, the outer surface of said sheathing being tapered towards the immersion end of said tube such that a minimum thickness of said sheathing is directly adjacent to and exposing said immersion end of said tube for minimizing trapped gases adjacent the measuring head when immersed into the metal bath, the opposite end of said sheathing from said tapered end forming a shoulder adjacent to said connector end of said tube; and

an elongated hollow support for receiving said shoulder of said sheathing in an abutting relationship such that the end of said tube is inserted into said support and said outer diameter of said sheathing and said support are substantially the same at said shoulder.

2. An immersion measuring probe as claimed in claim **1** wherin said thermocouple element further comprises a quartz tube having an aluminum oxide coating thereon.

3. An immersion measuring probe for measurements in a molten metal bath comprising:

an elongated hollow electrically conductive tube, said tube having an immersion end and a connector end;

a measuring head closing the internal portion of said immersion end of said tube, said measuring head having

a non-conductive support plug,

a thermocouple element supported by said plug and having one end projecting from said immersion end of said tube and an electrically conductive portion extending into said tube beyond said plug,

a gas impermeable enclosure receiving the electrically conductive portions of said thermocouple, said enclosure being closely adjacent to said measuring head within said tube;

electrical conductors extending from said enclosure to said connector end of said tube;

an electrical connector closing said connector end of said tube and providing an electrical connection for said thermocouple;

said tube between said plug and said connector being filled with a heat insulating particulate material which is loosely packed such that it is gas permeable;

a sheathing surrounding a major portion of the length of said tube, said sheathing being made of a fireproof, refractory heat resistant material attached to said tube exterior, the outer surface of said sheathing being tapered towards the immersion end of said tube such that a minimum thickness of said sheathing is directly adjacent to and exposing said immersion end of said tube for minimizing trapped gases adjacent to the measuring head when immersed in a metal bath, the opposite end of said sheathing from said tapered end forming a shoulder adjacent to said connector end of said tube; and

an elongated hollow support for receiving said shoulder of said sheathing in an abutting relationship such that the end of said tube is inserted into said support and said outer diameter of said sheathing and said support are substantially the same at said shoulder.

4. An immersion probe for measurements in a molten metal bath comprising:

an elongated hollow electrically conductive tube, said tube having an immersion end and a connector end;

a measuring head closing the internal portion of said immersion end of said tube, said measuring head having

a non-conductive support plug,

an electro-chemical cell extending through said plug having one end projecting form said immersion end of said tube and its opposite extending into said tube beyond said plug;

a gas impermeable enclosure receiving the electrically conductive portion of said cell, said enclosure being closely adjacent to said measuring head within said tube;

electrical conductors extending from said enclosure to said connector end of said tube;

an electrical connector closing said connector end of said tube and providing electrical connections for said cell and said tube;

said tube between said plug and said connector being filled with a heat insulating particulate material which is loosely packed such that it is gas permeable;

a sheathing surrounding a major portion of the length of said tube, said sheathing being made of a fireproof, refractory heat resistant material attached to said tube exterior, the outer surface of said sheathing being tapered towards the immersion end of said tube such that a minimum thickness of said sheathing is directly adjacent to and exposing said immersion end of said tube for minimizing trapped gases adjacent to the measuring head when immersed into a metal bath, the opposite end of said sheathing from said tapered end forming a shoulder adjacent to said connector end of said tube; and

an elongated hollow support for receiving said shoulder of said sheathing in an abutting relationship such that the end of said tube is inserted into said support and said outer diameter of said sheathing and said support are substantially the same at said shoulder.

5. An immersion measuring probe for measurements in a molten metal bath comprising:

an elongated hollow electrically conductive tube, said tube having an immersion end and a connector end;

a measuring head closing the internal portion of said immersion end of said tube, said measuring head having

a non-conductive support plug,

a thermocouple element supported by said plug and having one end projecting from said immersion end of said tube and an electrically conductive portion extending into said tube beyond said plug,

an electrochemical cell extending through said plug having one end projecting from the immersion end of said tube adjacent to said projecting end of the thermocouple element and an electrically conducting portion extending into said tube beyond said plug;

means within said tube for receiving the electrically conductive portions of said thermocouple and said cell;

electrical conductors extending from said receiving means to said connector end of said tube;

an electrical connector closing said connector end of said tube and providing electrical connections for said thermocouple, said cell and said tube;

said tube between said plug and said connector being filled with a heat insulating particulate material which is loosely packed such that it is gas permeable;

a sheathing surrounding a major portion of the length of said tube, said sheathing being made of a fireproof, refractory heat resistant material attached to the exterior of said tube, the outer surface of said sheathing being tapered towards the immersion end of said tube such that a minimum thickness of said sheathing is directly adjacent to and exposing said immersion end of said tube for minimizing trapped gases adjacent the measuring head when immersed into the metal bath, the opposite end of said sheathing from said tapered end forming a shoulder adjacent to said connector end of said tube; and

an elongated hollow support for receiving said shoulder of said sheathing in an abutting relationship such that the end of said tube is inserted into said support and said outer diameter of said sheathing and said support are substantially the same at said shoulder.

6. An immersion measuring probe for measurements in a molten metal bath comprising:

an elongated hollow electrically conductive tube, said tube having an immersion end and a connector end;

a measuring head closing the internal portion of said immersion end of said tube, said measuring head having

a non-conductive support plug,

a thermocouple element supported by said plug and having one end projecting from said immersion end of said tube and having an electrically conductive portion extending into said tube beyond said plug,

means within said tube for receiving the electrically conductive portion of said thermocouple;

electrical conductors extending from said receiving means to said connector end of said tube;

an electrical connector closing said connector end of said tube and providing an electrical connection for said thermocouple;

said tube between said plug and said connector being filled with a heat insulating particulate material which is loosely packed such that it is gas permeable;

sheathing surrounding a major portion of the length of said tube, said sheathing being made of a fireproof, refractory heat resistant material attached to said tube exterior, the outer surface of said sheathing being tapered towards the immersion end of said tube such that a minimum thickness of said sheathing is directly adjacent to and exposing said immersion end of said tube for minimizing trapped gases adjacent to the measuring head when immersed in a metal bath, the opposite end of said sheathing form said tapered end forming a shoulder adjacent to said connector end of said tube; and

an elongated hollow support for receiving said shoulder of said sheathing in an abutting relationship such that the end of said tube is inserted into said support and said outer diameter of said sheathing and said support are substantially the same at said shoulder.

7. An immersion probe for measurements in a molten metal bath comprising:

an elongated hollow electrically conductive tube, said tube having an immersion end and a connector end;

a measuring head closing the internal portion of said immersion end of said tube, said measuring head having

a non-conductive support plug,

an electrochemical cell extending through said plug having one end projecting form said immersion end of said tube and an electrically conductive portion extending into said tube beyond said plug;

means within said tube for receiving the electrically conductive portion of said cell;

electrical conductors extending from said receiving means to said connector end of said tube;

an electrical connector closing said connector end of said tube and providing electrical connections for said cell and said tube;

said tube between said plug and said connector being filled with a heat insulating particulate material which is loosely packed such that it is gas permeable;

sheathing surrounding a major portion of the length of said tube, said sheathing being made of a fireproof, refractory heat resistant material attached to said tube exterior, the outer surface of said sheathing being tapered towards the immersion end of said tube such that a minimum thickness of said sheathing is directly adjacent to and exposing said immersion end of said tube for minimizing trapped gases adjacent to the measuring head when immersed into a metal bath, the opposite end of said sheathing from said tapered end forming a shoulder adjacent to said connector end of said tube; and

an elongated hollow support for receiving said shoulder of said sheathing in an abutting relationship such that the end of said tube is inserted into said support and said outer diameter of said sheathing and said support are substantially the same at said shoulder.

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(12) EX PARTE REEXAMINATION CERTIFICATE (5121st)

United States Patent

Cure et al.

(10) Number: US 4,964,736 C1

(45) Certificate Issued: Jun. 14, 2005

(54) **IMMERSION MEASURING PROBE FOR USE IN MOLTEN METALS**

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(73) Assignee: **Heraeus Electro-Nite Co.**

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(30) **Foreign Application Priority Data**

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(52) **U.S. Cl.** **374/140**; 374/139; 136/234

(58) **Field of Search** 374/140, 139, 374/157, 142; 136/230, 232, 234; 204/422, 423, 210

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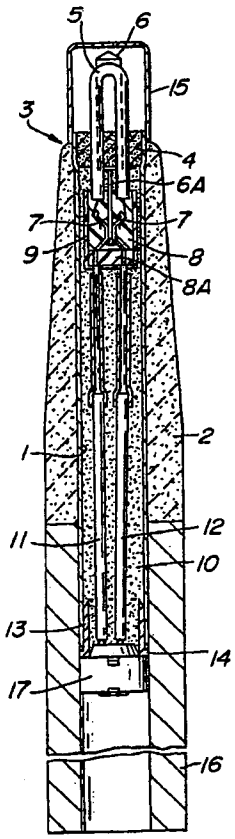
Primary Examiner—Diego F. F. Gutierrez

(57) **ABSTRACT**

An immersion probe as a preassembled unit includes a measuring head having a measuring element protected for minimizing trapping of gases by a sheath. The sheath is tapered toward a free end. The probe is adapted to be immersed in molten metal for measuring temperature and/or oxygen content.



EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

NO AMENDMENTS HAVE BEEN MADE TO THE PATENT

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims 1–7 is confirmed.

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